

**What is claimed is:**

1        1. A method of forming an image sensor device, comprising  
2 the steps of:  
3              forming an image sensing array in a substrate, wherein the  
4              image sensing array comprises a plurality of  
5              photosensors with spaces therebetween;  
6              forming a first dielectric layer overlying the spaces but  
7              not the photosensors;  
8              forming a conformal second dielectric layer on a sidewall  
9              of the first dielectric layer, wherein the second  
10          dielectric layer has a second refractive index; and  
11          forming a third dielectric layer overlying the photosensors  
12          but not the spaces, wherein the third dielectric layer  
13          has a third refractive index;  
14          wherein the third refractive index is greater than the  
15          second refractive index.

1        2. The method according to claim 1, wherein the  
2 photosensors are photodiodes.

1        3. The method according to claim 2, wherein the  
2 photodiodes comprise n-type regions in p-type regions.

1        4. The method according to claim 1, wherein the method  
2 of forming the first dielectric layer, the second dielectric  
3 layer and the third dielectric layer comprises the steps of:  
4              forming the first dielectric layer overlying the  
5              photosensors and the spaces;  
6              patterning the first dielectric layer by removing part of  
7              the first dielectric layer to form an opening above

8           each photosensor while maintaining the first  
9           dielectric layer overlying the spaces;  
10          forming a dielectric layer on the first dielectric layer  
11          and an inner surface of the opening;  
12          anisotropically etched back part of the dielectric layer  
13          to form the second dielectric layer on the sidewall  
14          of the opening;  
15          forming the third dielectric layer overlying the first  
16          dielectric layer, the second dielectric layer and  
17          the opening; and  
18          removing part of the third dielectric layer to the first  
19          dielectric layer while maintaining the third  
20          dielectric layer in the opening.

1       5. The method according to claim 4, wherein the step of  
2 patterning the first dielectric layer uses the same reticle that  
3 is used for defining ion implantation regions for the  
4 photosensors.

1       6. The method according to claim 4, further comprising  
2 the step of:

3       performing a planarization to make the top surfaces of the  
4           first dielectric layer, the second dielectric layer  
5           and the third dielectric layer are coplanar.

1       7. The method according to claim 6, wherein the  
2 planarization comprises chemical mechanical polishing.

1       8. The method according to claim 1, wherein the first  
2 dielectric layer comprises at least one interlevel dielectric  
3 (ILD) layer.

1        9. The method according to claim 8, wherein the first  
2 dielectric layer further comprises at least one intermetal  
3 dielectric (IMD) layer.

1        10. The method according to claim 9, wherein the IMD layer  
2 has multiple dielectric films.

1        11. The method according to claim 10, wherein the multiple  
2 dielectric films comprise SiON, SiN and FSG (Fluorinated Silica  
3 Glass) films.

1        12. The method according to claim 11, wherein the second  
2 dielectric layer is a low-k dielectric layer.

1        13. The method according to claim 12, wherein the low-k  
2 dielectric layer is a FLARE, SiLK, FLAC (fluorinated amorphous  
3 silicon), fluoro polymer or porous silica layer.

1        14. The method according to claim 13, wherein the third  
2 dielectric layer is a TEOS-SiO<sub>2</sub> layer formed by PECVD.

1        15. The method according to claim 1, wherein the third  
2 refractive index is greater than the second refractive index  
3 by at least about 0.1.

1        16. A method of forming an image sensor device, comprising  
2 the steps of:

3              forming an image sensing array in a substrate, wherein the  
4              image sensing array comprises a plurality of  
5              photosensors with spaces therebetween;  
6              forming a first dielectric layer of a multi-dielectric  
7              structure overlying the photosensors and the spaces;

8        patterning the first dielectric layer by removing part of  
9                  the first dielectric layer to form an opening above  
10                 each photosensor while maintaining the first  
11                 dielectric layer overlying the spaces;  
12        forming a dielectric layer on the first dielectric layer  
13                 and an inner surface of the opening;  
14        anisotropically etched back part of the dielectric layer  
15                 to form a conformal second dielectric layer on the  
16                 sidewall of the opening, wherein the second  
17                 dielectric layer has a second refractive index;  
18        forming a third dielectric layer overlying the first  
19                 dielectric layer, the second dielectric layer and  
20                 the opening, wherein the third dielectric layer has  
21                 a third refractive index; and  
22        removing part of the third dielectric layer to the first  
23                 dielectric layer while maintaining the third  
24                 dielectric layer in the opening;  
25        wherein the third refractive index is greater than the  
26                 second refractive index;  
27        whereina light guide comprising the second dielectric layer  
28        and the third dielectric layer is formed overlying each  
29        photosensor, thereby preventing incident light from striking  
30        other photosensors.

1        17. The method according to claim 16, wherein the  
2        photosensors are photodiodes.

1        18. The method according to claim 17, wherein the  
2        photodiodes comprise n-type regions in p-type regions.

1        19. The method according to claim 16, wherein the step  
2 of patterning the first dielectric layer uses the same reticle  
3 that is used for defining ion implantation regions for the  
4 photosensors.

1        20. The method according to claim 16, further comprising  
2 the step of:

3              performing planarization to make the top surfaces of the  
4              first dielectric layer, the second dielectric layer,  
5              and the third dielectric layer coplanar.

1        21. The method according to claim 20, wherein the  
2 planarization comprises chemical mechanical polishing.

1        22. The method according to claim 16, wherein the  
2 multi-dielectric structure comprises SiON, SiN and FSG  
3 (Fluorinated Silica Glass) films.

1        23. The method according to claim 22, wherein the second  
2 dielectric layer is a low-k dielectric layer.

1        24. The method according to claim 23, wherein the low-k  
2 dielectric layer is a FLARE, SiLK, FLAC (fluorinated amorphous  
3 silicon), fluoro polymer or porous silica layer.

1        25. The method according to claim 24, wherein the third  
2 dielectric layer is a TEOS-SiO<sub>2</sub> layer formed by PECVD.

1        26. The method according to claim 16, wherein the third  
2 refractive index is greater than the second refractive index  
3 by at least about 0.1.

1        27. The method according to claim 16, wherein a thickness  
2        of the second dielectric layer is 200~2000Å.

1        28. An image sensor device, comprising:  
2              an image sensing array in a substrate, wherein the image  
3              sensing array comprises a plurality of photosensors  
4              with spaces therebetween;  
5              a first dielectric layer overlying the spaces but not the  
6              photosensors;  
7              a conformal second dielectric layer on a sidewall of the  
8              first dielectric layer, wherein the second dielectric  
9              layer has a second refractive index; and  
10          a third dielectric layer overlying the photosensors but  
11          not the spaces, wherein the third dielectric layer  
12          has a third refractive index;  
  
13          wherein the third refractive index is greater than the  
14          second refractive index.

1        29. The device according to claim 28, wherein the  
2        photosensors are photodiodes.

1        30. The device according to claim 29, wherein the  
2        photodiodes comprise n-type regions in p-type regions.

1        31. The device according to claim 28, wherein top surfaces  
2        of the first dielectric layer, the second dielectric layer and  
3        the third dielectric layer are coplanar.

1        32. The device according to claim 28, wherein the first  
2        dielectric layer comprises at least one interlevel dielectric  
3        (ILD) layer.

1       33. The device according to claim 32, wherein the ILD layer  
2 is a silicon oxide or BPSG (borophosphosilicate glass) layer.

1       34. The device according to claim 32, wherein the first  
2 dielectric layer further comprises at least one intermetal  
3 dielectric (IMD) layer.

1       35. The device according to claim 34, wherein the IMD layer  
2 has multiple dielectric films.

1       36. The device according to claim 35, wherein the multiple  
2 dielectric films comprise SiON, SiN and FSG (Fluorinated Silica  
3 Glass) films.

1       37. The device according to claim 36, wherein the second  
2 dielectric layer is a low-k dielectric layer.

1       38. The device according to claim 37, wherein the low-k  
2 dielectric layer is a FLARE, SiLK, FLAC (fluorinated amorphous  
3 silicon), fluoro polymer or porous silica layer.

1       39. The device according to claim 38, wherein the third  
2 dielectric layer is a TEOS-SiO<sub>2</sub> layer formed by PECVD.

1       40. The device according to claim 28, wherein the third  
2 refractive index is greater than the second refractive index  
3 by at least about 0.1.

1       41. The device according to claim 28, wherein a thickness  
2 of the second dielectric layer is 200~2000Å.